US006107586A

United States Patent [19]

Takeuchi et al.

[11] Patent Number: 6,107,586

[45] Date of Patent: Aug. 22, 2000

[54] **PUSH-ON SWITCH**

[75] Inventors: **Masatsugu Takeuchi**; **Hisashi Watanabe**, both of Okayama-ken; **Hiroshi Matsui**, Osaka, all of Japan

[73] Assignee: **Matsushita Electric Industrial Co., Ltd.**, Osaka, Japan

[21] Appl. No.: **09/181,866**

[22] Filed: **Oct. 29, 1998**

[30] **Foreign Application Priority Data**

Nov. 13, 1997 [JP] Japan 9-311759

[51] **Int. Cl.**[7] **H01H 1/26**

[52] **U.S. Cl.** **200/535**; 200/520

[58] **Field of Search** 200/512, 517, 200/520, 534, 559, 561, 245, 341, 239

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,809,838	5/1974	Coppola	200/159
4,438,304	3/1984	Kennedy	200/67 D
4,499,342	2/1985	Nakayama	200/5 E
4,952,762	8/1990	Koyanagi	200/517
5,158,172	10/1992	Roeser et al.	200/553
5,345,051	9/1994	Miike	200/345

Primary Examiner—Michael L. Gellner
Assistant Examiner—Nhung Nguyen
Attorney, Agent, or Firm—Louis Woo

[57] **ABSTRACT**

A push-on switch includes a casing made of insulating material and having an inner bottom surface. First fixed contacts are provided on the inner bottom surface of the casing. Second fixed contacts are provided on the inner bottom surface of the casing. Movable contacts have base portions and resilient contact arms. The base portions are placed on and electrically connected to the first fixed contacts respectively. The resilient contact arms extend from the base portions to regions above the second fixed contacts respectively. A dome-shaped spring member made of resilient insulating material has a top portion, a conical portion, and a lower end. The top portion and the lower end are connected by the conical portion. The lower end is placed on the base portions of the movable contacts. The top portion has a lower surface located above free ends of the resilient contact arms of the movable contacts. A lid member fixed to the casing has a hole through which the top portion of the dome-shaped spring member extends. The lid member presses the lower end of the dome-shaped spring member against the base portions of the movable contacts. As the top portion of the dome-shaped spring member is depressed, the dome-shaped spring member brings the resilient contact arms into contact with the second fixed contacts respectively.

10 Claims, 17 Drawing Sheets

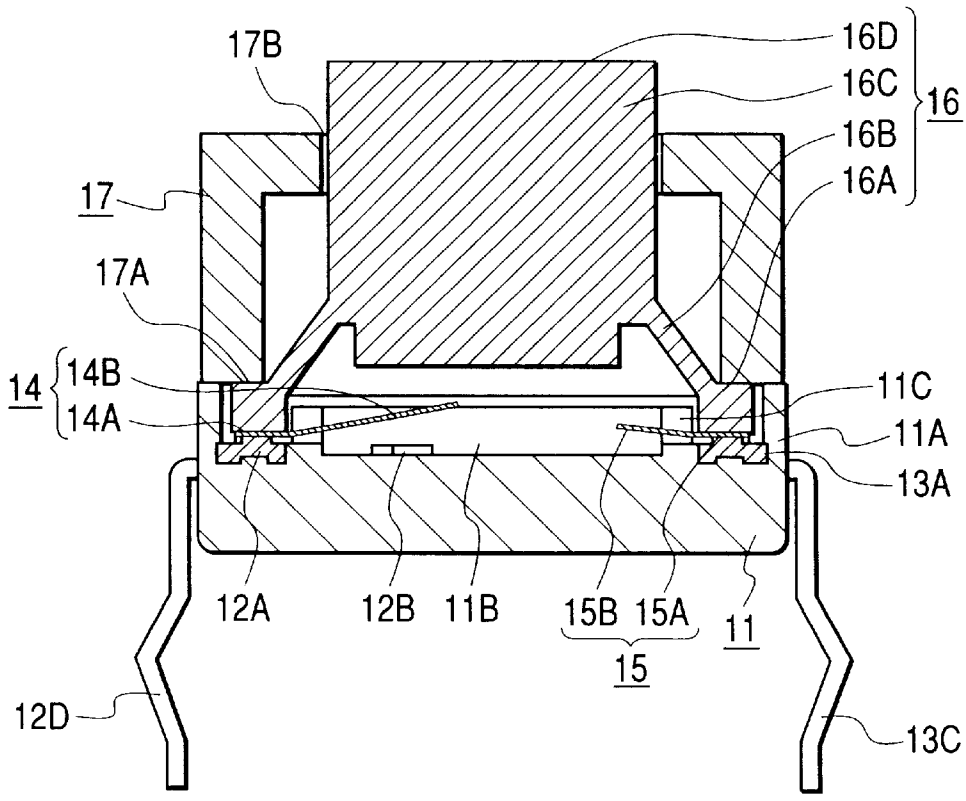


FIG. 1
PRIOR ART

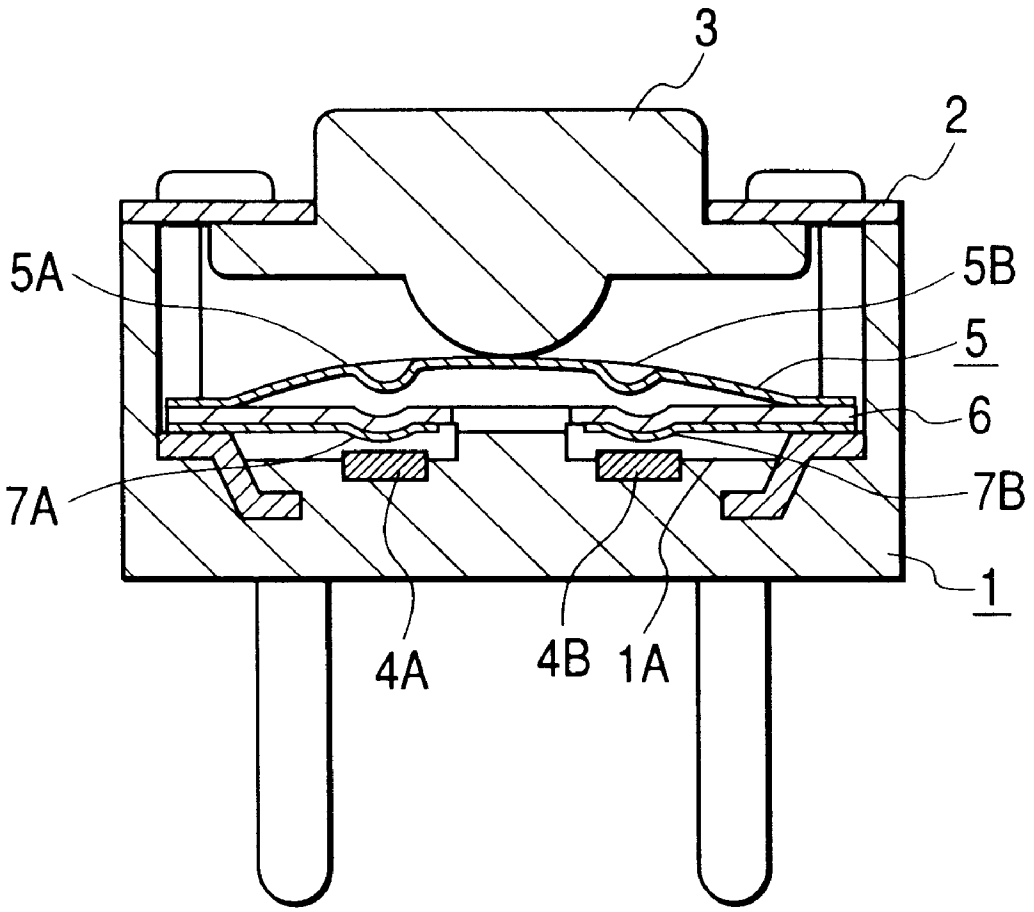


FIG. 2
PRIOR ART

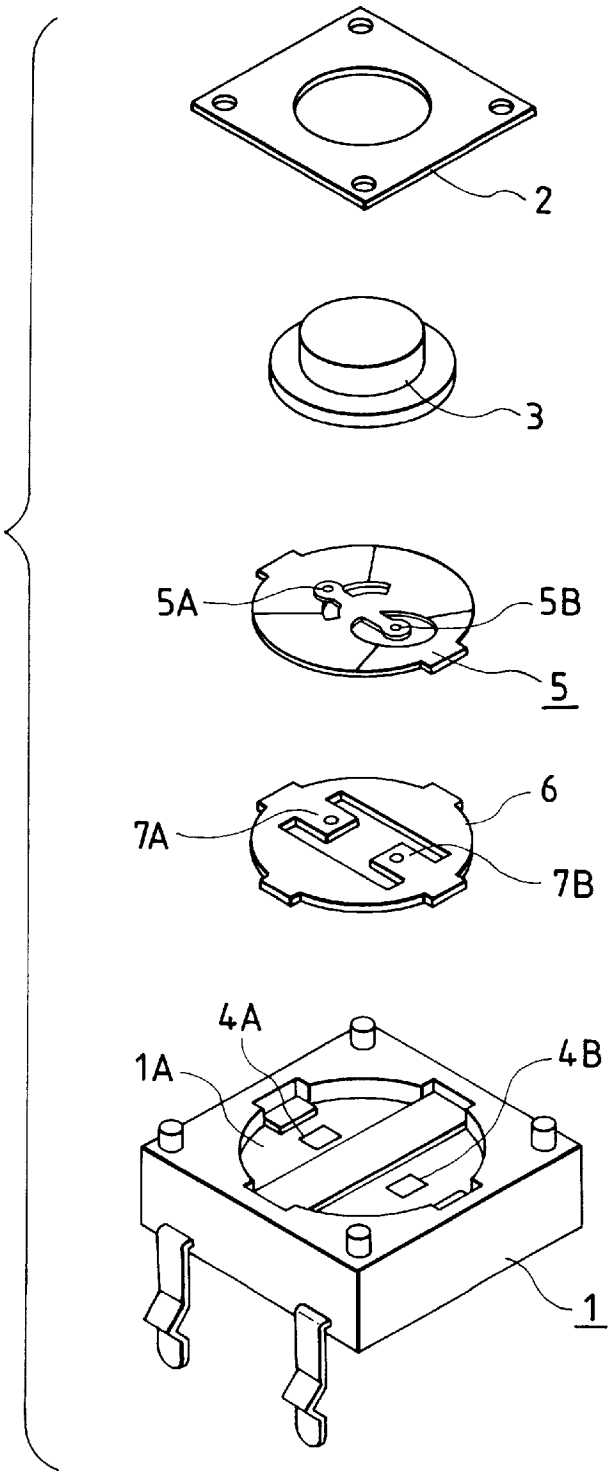


FIG. 3

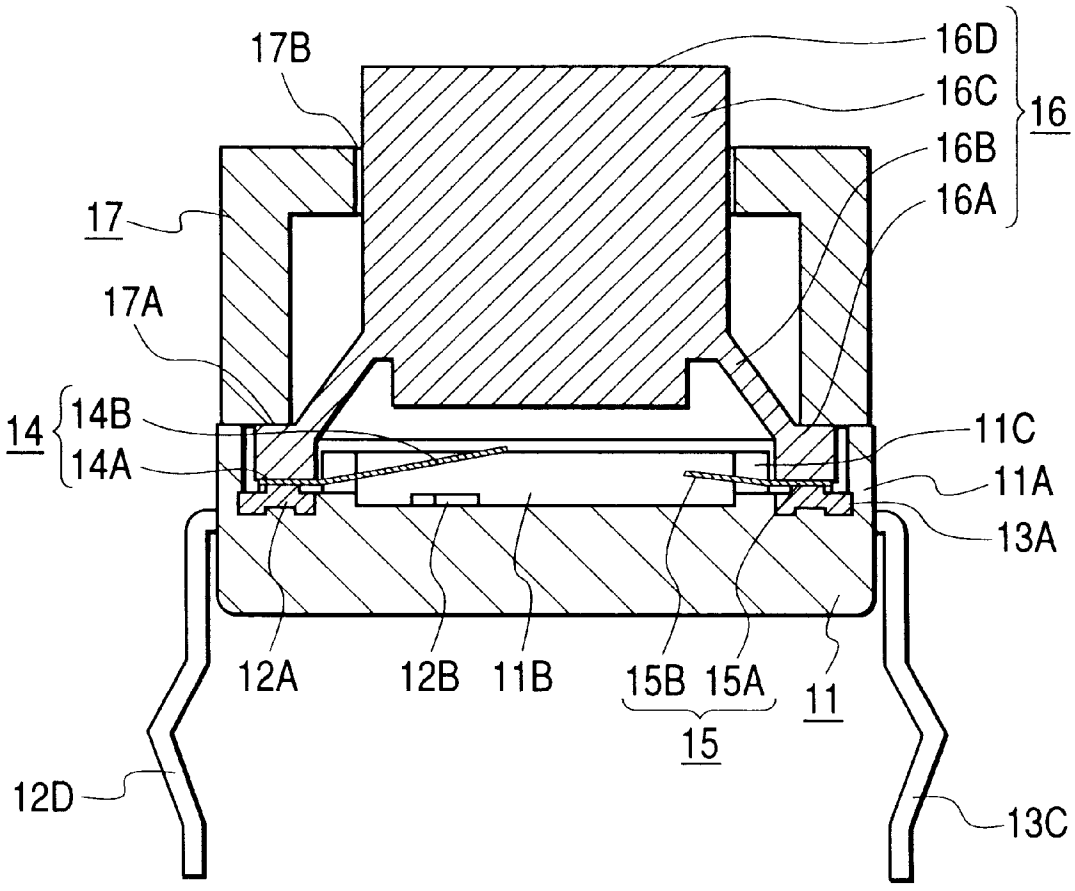

17B
16D
16C
16
16B
16A
17
17A
14
14B
14A
11C
11A
13A
12A
12B
11B
15B
15A
11
15
12D
13C

FIG. 4

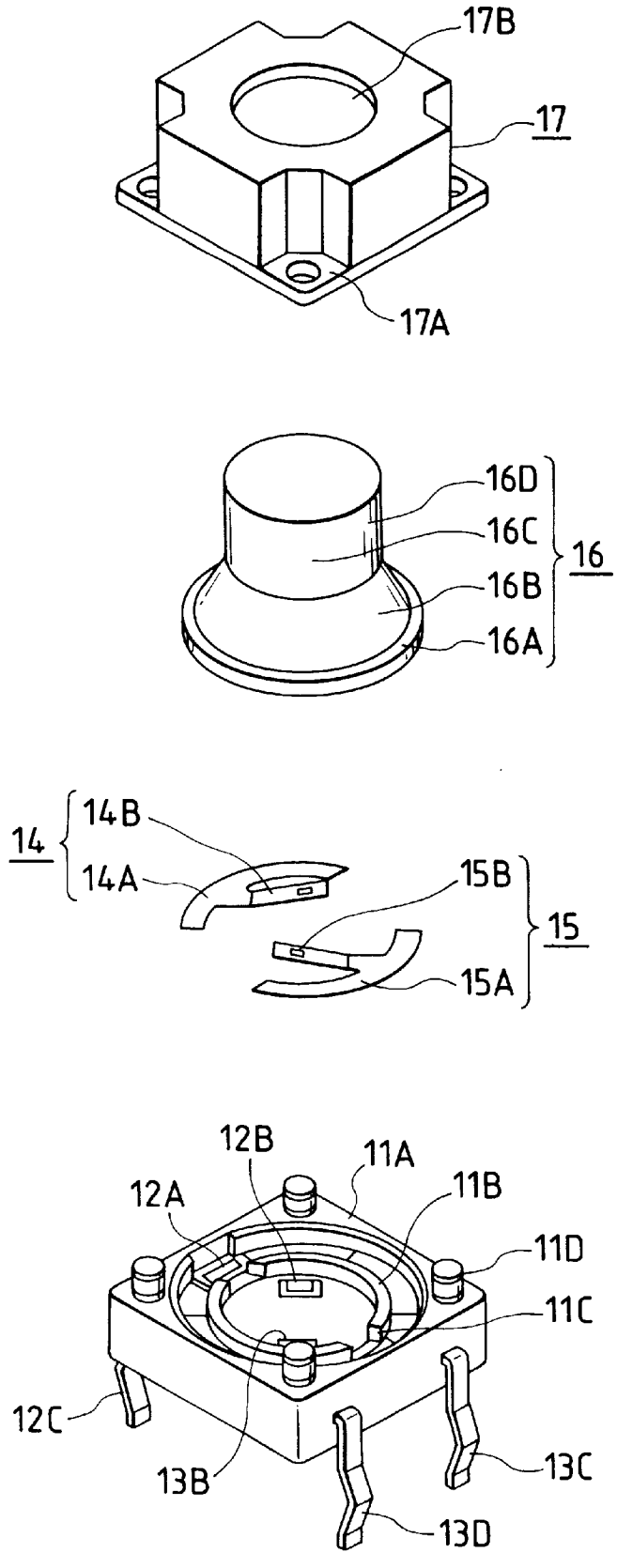

17B
17
17A
16D
16C
16B
16A
16
14
14B
14A
15B
15A
15
12B
11A
12A
11B
11D
11C
12C
13B
13C
13D

FIG. 5

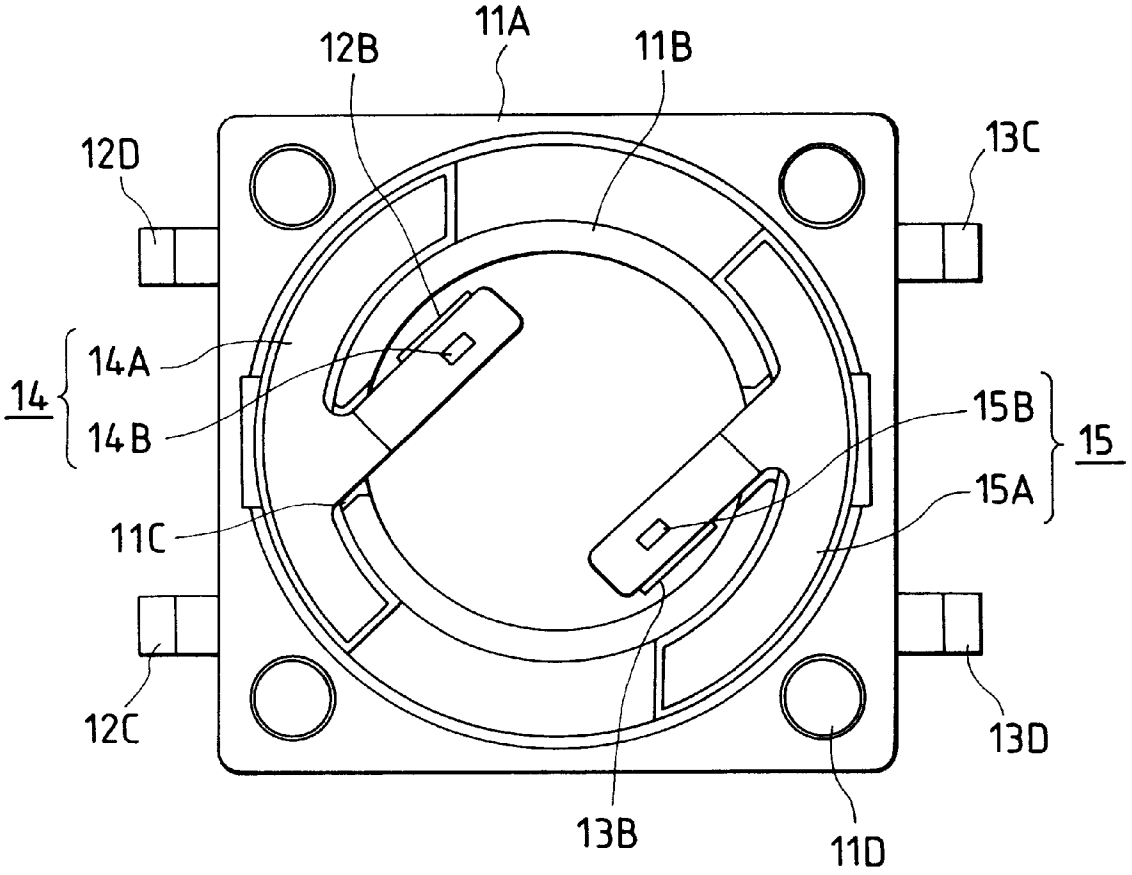


FIG. 6

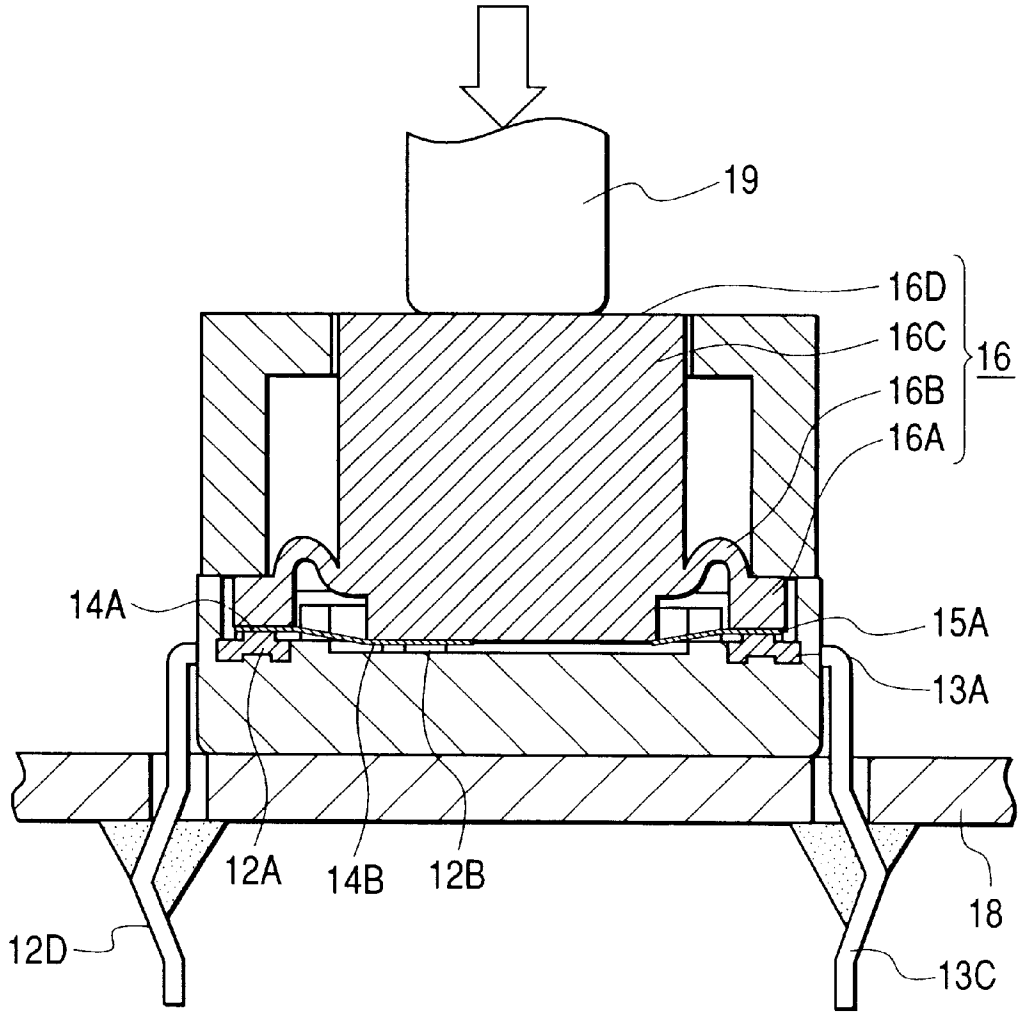


FIG. 7

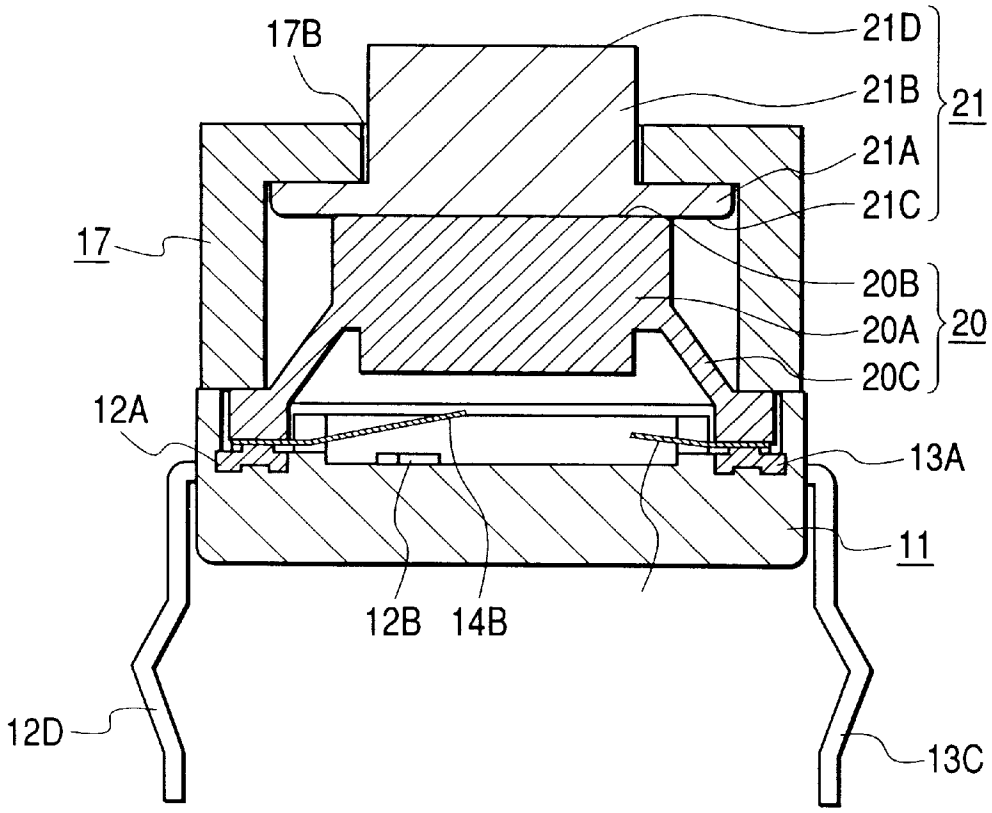

17B
21D
21B
21
21A
21C
17
20B
20A
20
20C
12A
13A
11
12B
14B
12D
13C

FIG. 8

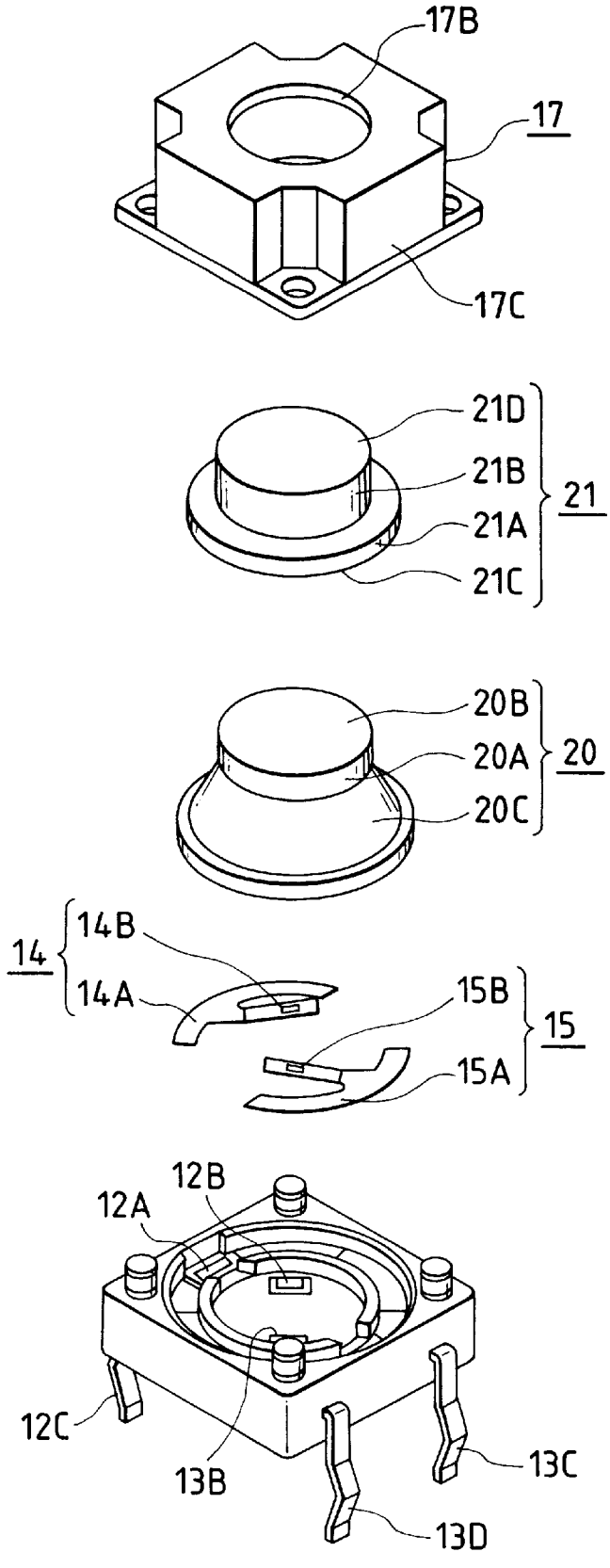

17B
17
17C
21D
21B
21A
21C
21
20B
20A
20C
20
14
14B
14A
15B
15A
15
12B
12A
12C
13B
13C
13D

FIG. 9

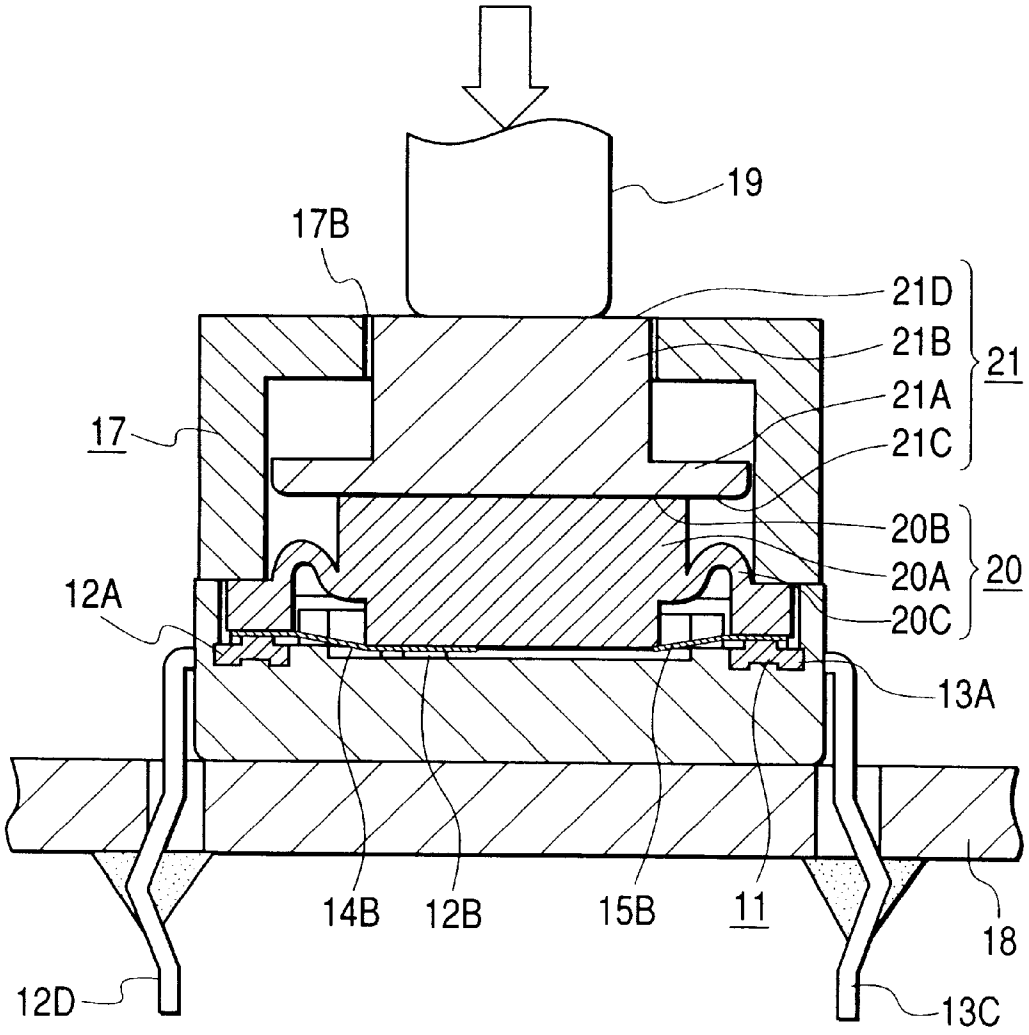

19
17B
21D
21B
21
21A
17
21C
20B
20A
20
12A
20C
13A
14B
12B
15B
11
18
12D
13C

FIG. 10

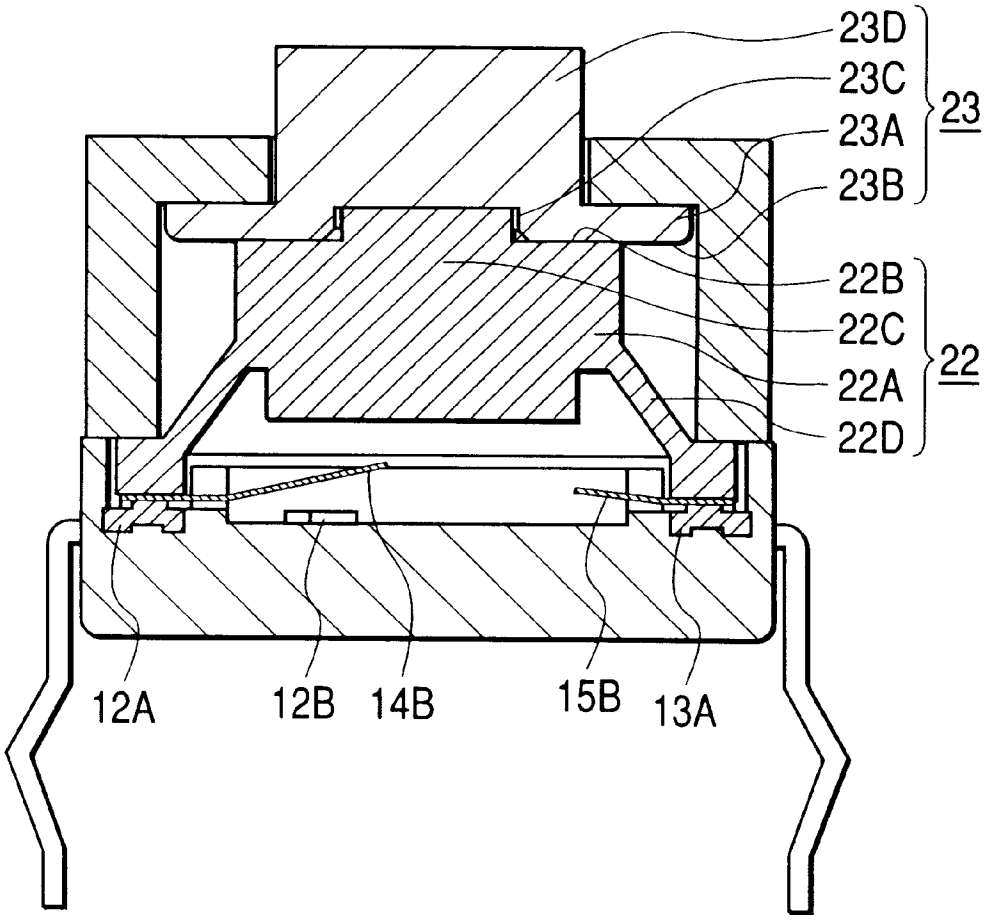


FIG. 11

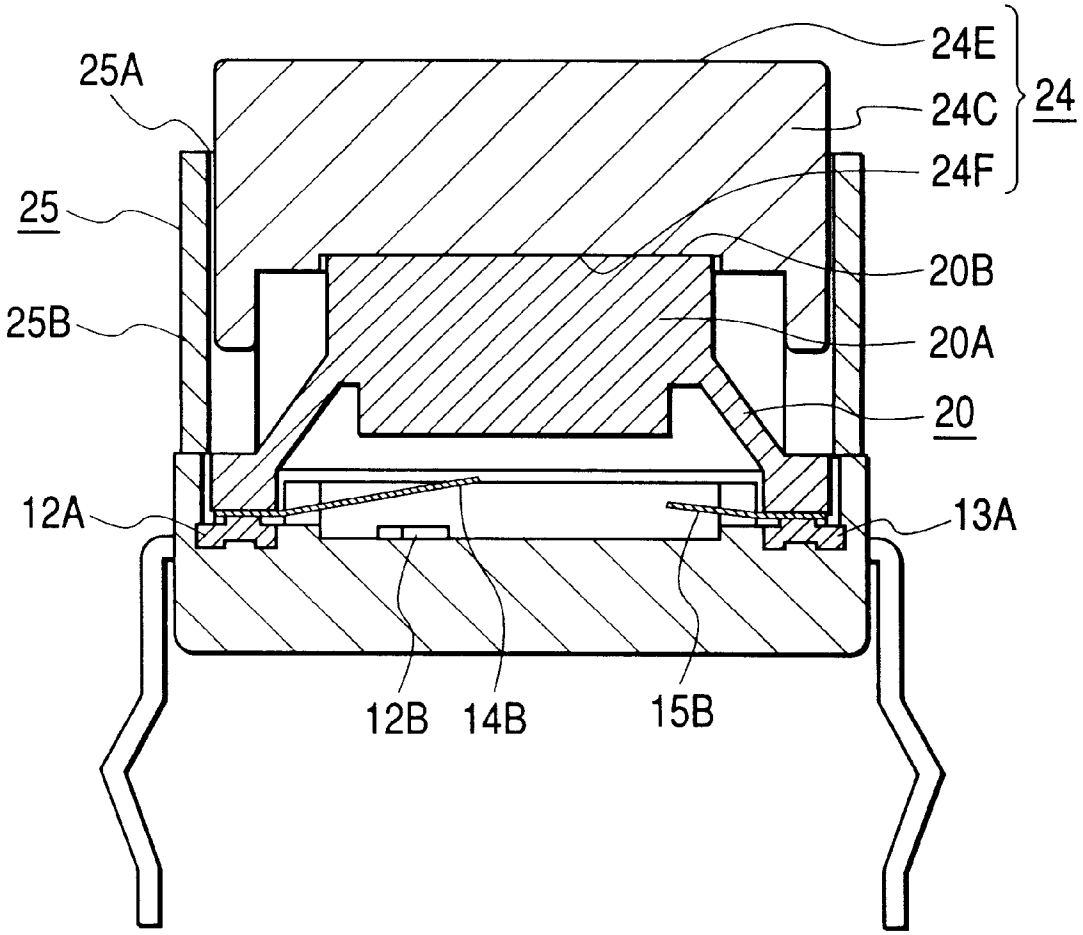


FIG. 12

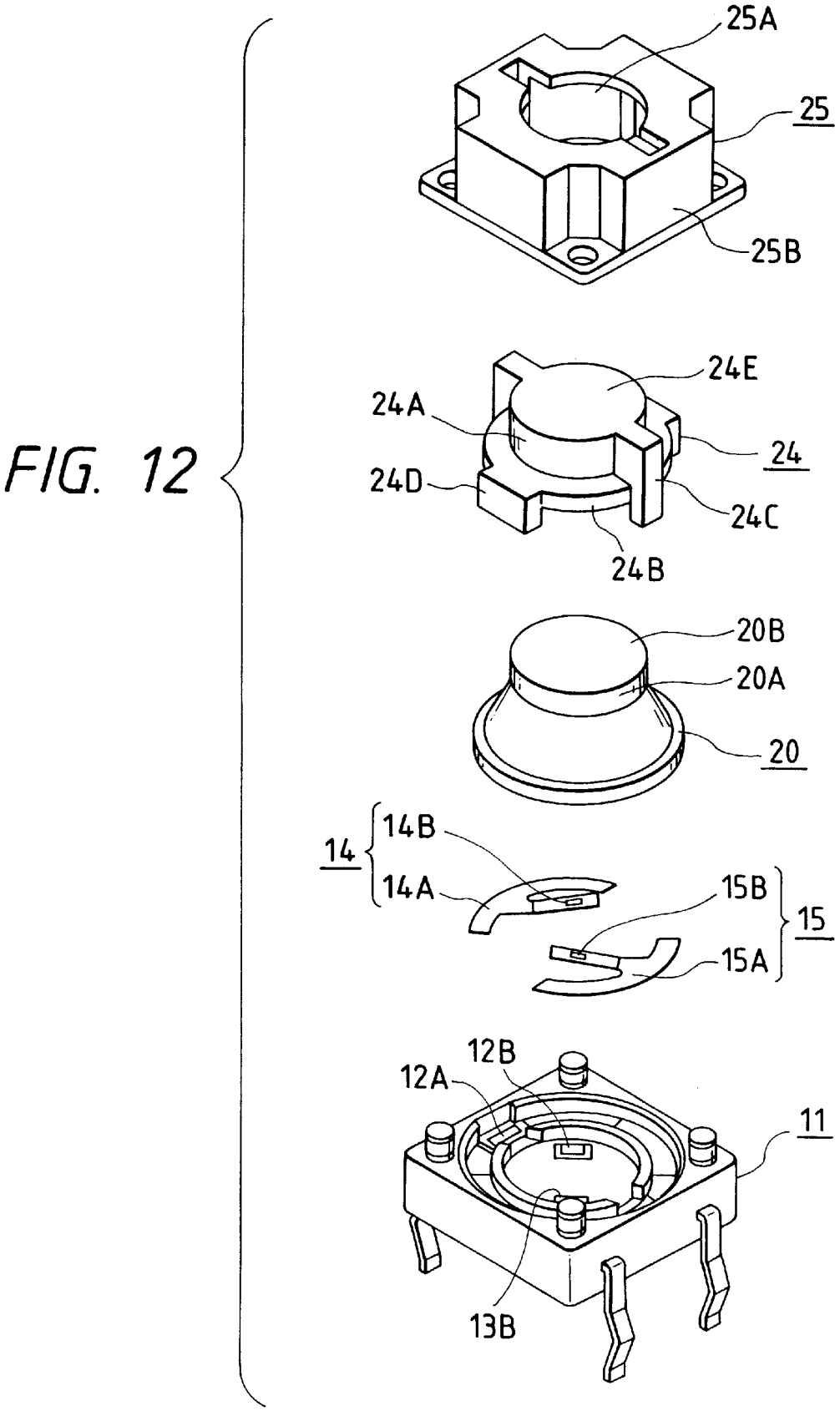

25A
25
25B
24E
24A
24
24D
24C
24B
20B
20A
20
14
14B
14A
15B
15
15A
12B
12A
11
13B

FIG. 13

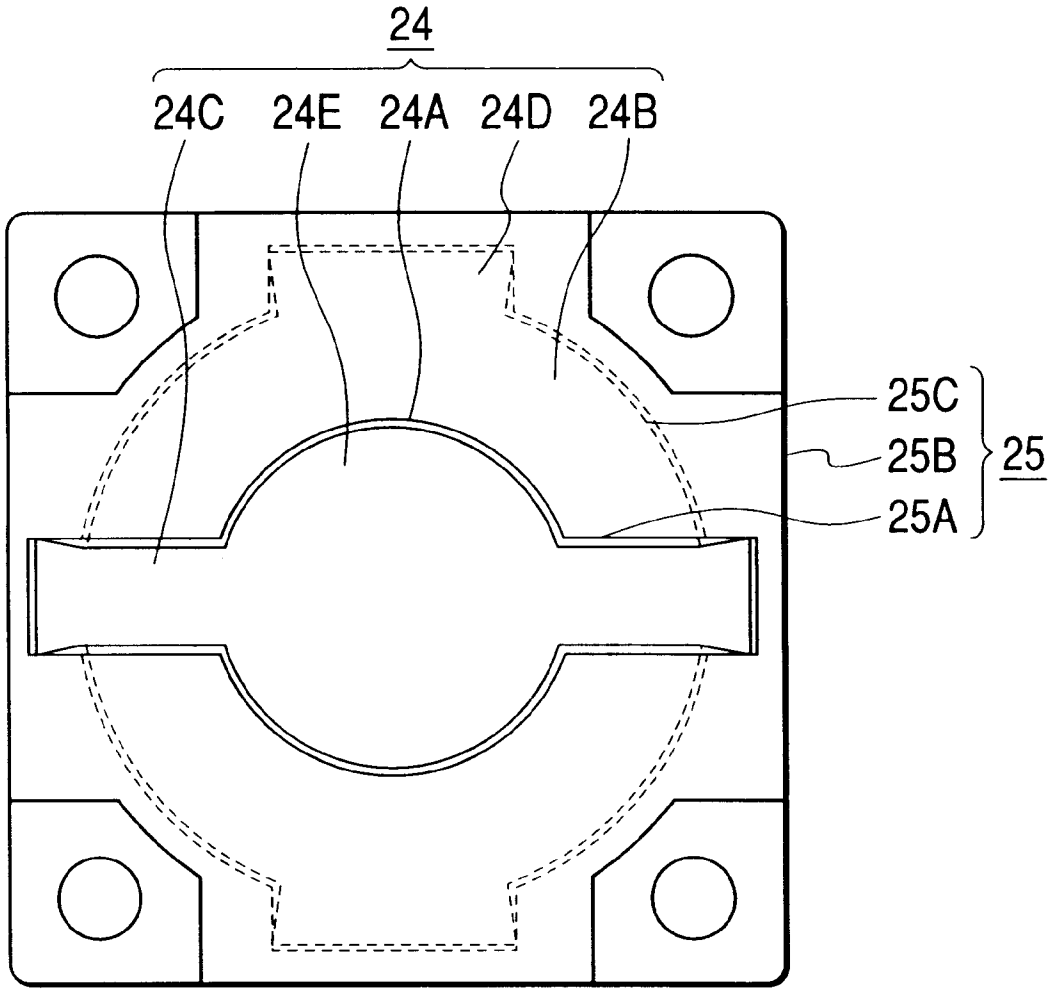


FIG. 14

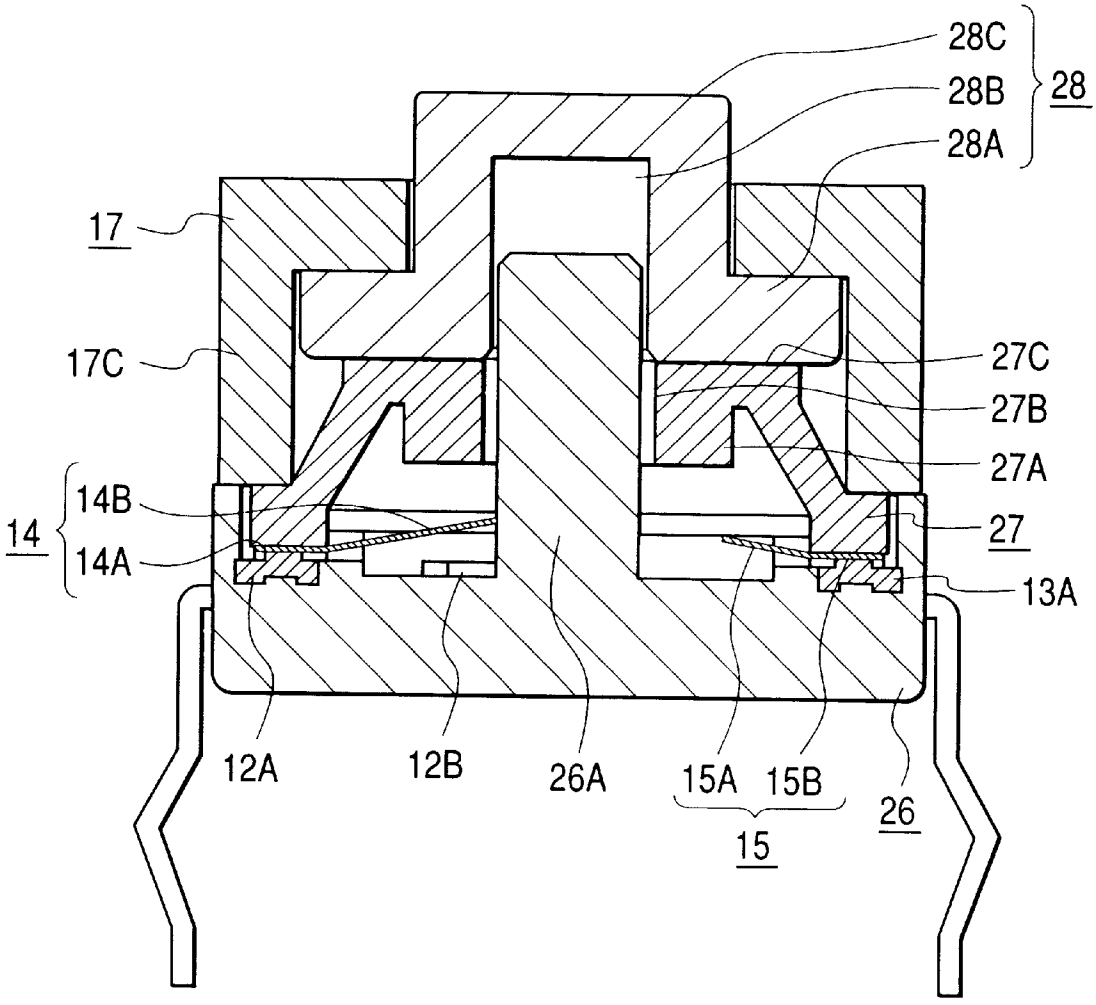

28C
28B
28A
28
17
17C
27C
27B
27A
14B
14
14A
27
13A
12A
12B
26A
15A
15B
15
26

FIG. 15

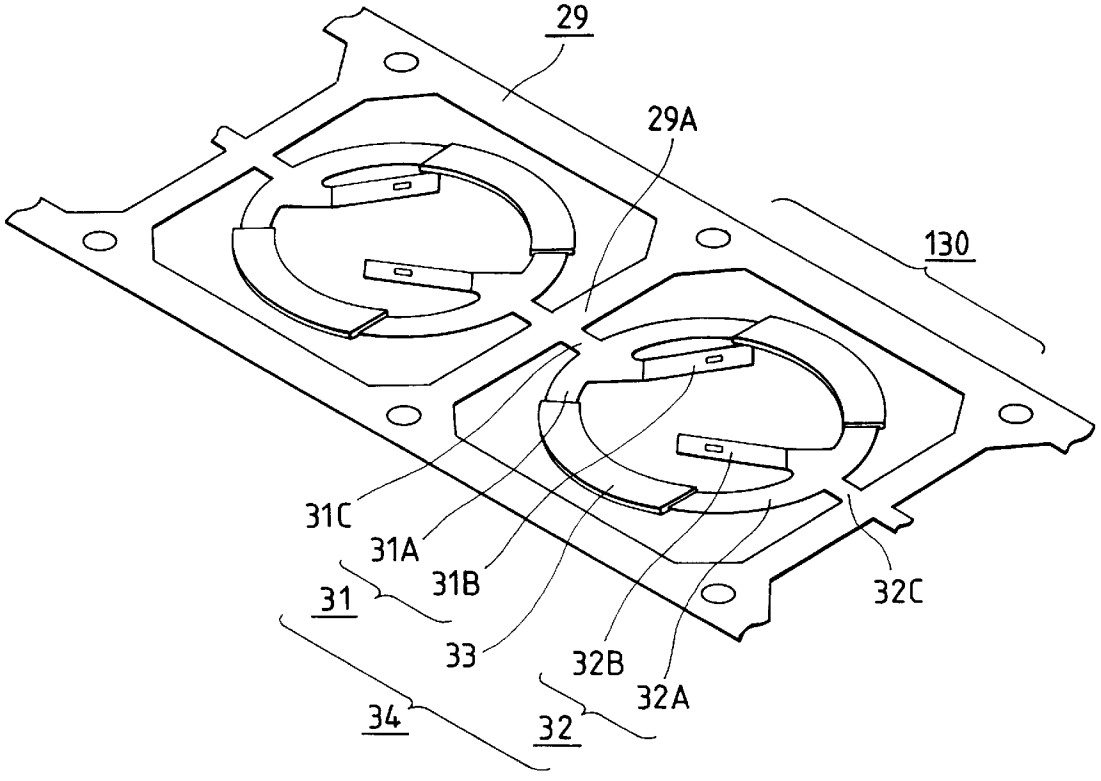


FIG. 16

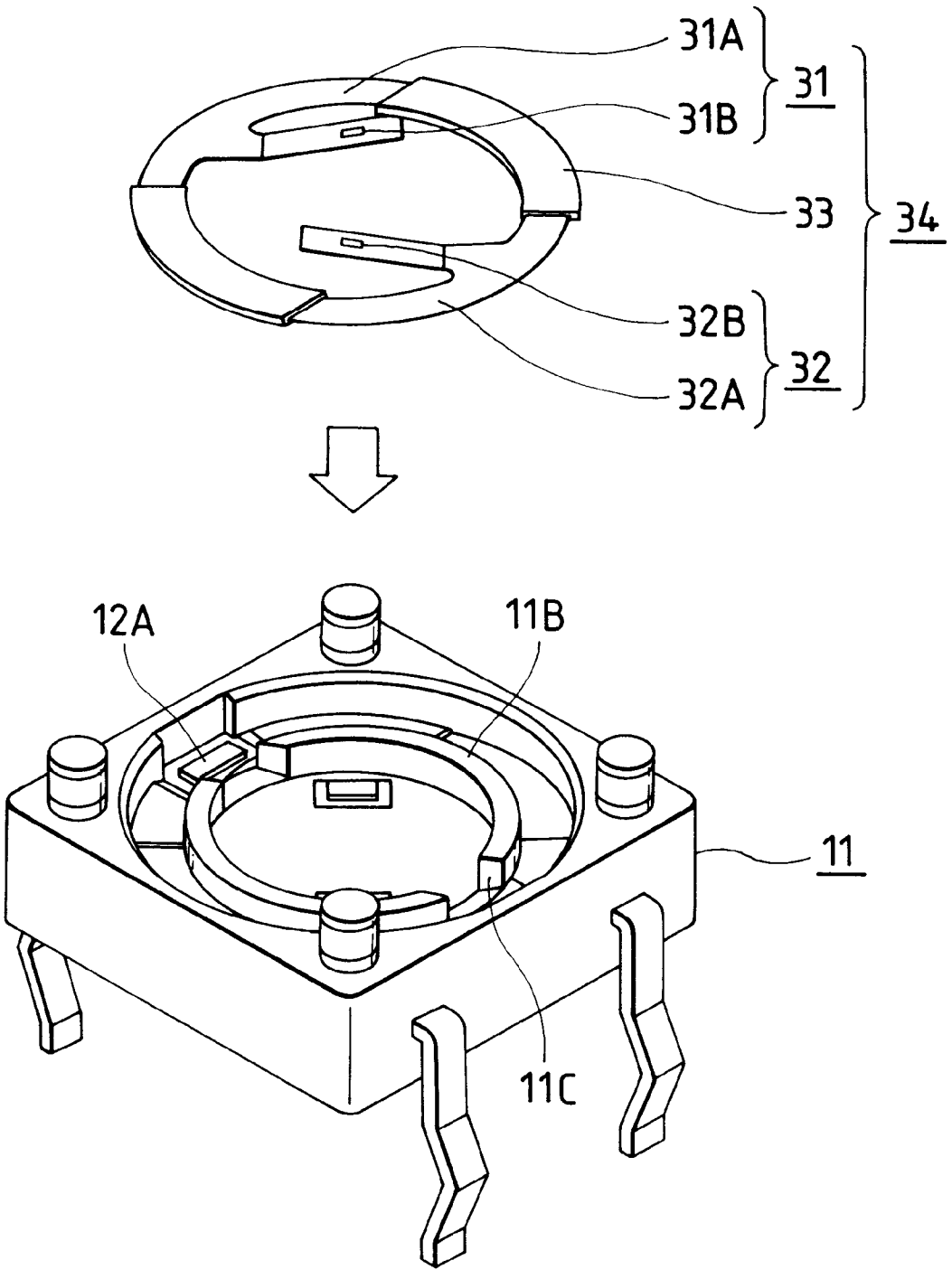
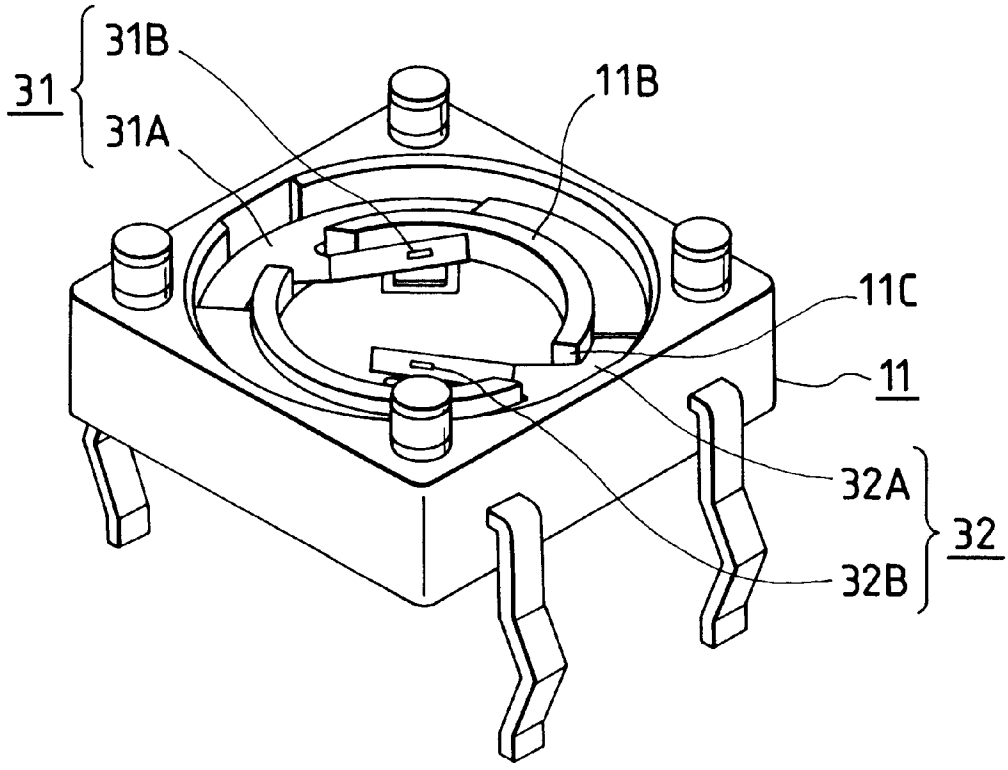


FIG. 17



PUSH-ON SWITCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a push-on switch having a plurality of independent circuit switching portions.

2. Description of the Related Art

In general, electronic apparatuses such as telephone sets and facsimile machines have input button switches including push-on switches. In prior-art push-on switches, the shapes of contact portions are relatively complicated. Furthermore, each of the contact portions has a large number of parts. Thus, general methods of manufacturing the prior-art push-on switches have many steps. Accordingly, the prior-art push-on switches tend to be high in cost.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved push-on switch.

A first aspect of this invention provides a push-on switch comprising a casing made of insulating material and having an inner bottom surface; first fixed contacts provided on the inner bottom surface of the casing; second fixed contacts provided on the inner bottom surface of the casing; movable contacts having base portions and resilient contact arms, the base portions being placed on and electrically connected to the first fixed contacts respectively, the resilient contact arms extending from the base portions to regions above the second fixed contacts respectively; a dome-shaped spring member made of resilient insulating material and having a top portion, a conical portion, and a lower end, the top portion and the lower end being connected by the conical portion, the lower end being placed on the base portions of the movable contacts, the top portion having a lower surface located above free ends of the resilient contact arms of the movable contacts; and a lid member fixed to the casing and having a hole through which the top portion of the dome-shaped spring member extends, the lid member pressing the lower end of the dome-shaped spring member against the base portions of the movable contacts; wherein as the top portion of the dome-shaped spring member is depressed, the dome-shaped spring member brings the resilient contact arms into contact with the second fixed contacts respectively.

A second aspect of this invention is based on the first aspect thereof, and provides a push-on switch wherein the casing has a projection at the inner bottom surface thereof, the projection extending along a circle, the base portions of the movable contacts being located between the projection and an outer side wall of the casing, the projection having grooves through which the resilient contact arms of the movable contacts extend, the lower end of the dome-shaped spring member being located between the projection and the outer side wall of the casing.

A third aspect of this invention is based on the first aspect thereof, and provides a push-on switch wherein the base portions of the movable contacts are connected by insulating members while lower surfaces of the base portions of the movable contacts are uncovered from the insulating members.

A fourth aspect of this invention provides a push-on switch comprising a casing made of insulating material and having an inner bottom surface; first fixed contacts provided on the inner bottom surface of the casing; second fixed contacts provided on the inner bottom surface of the casing;

movable contacts having base portions and resilient contact arms, the base portions being placed on and electrically connected to the first fixed contacts respectively, the resilient contact arms extending from the base portions to regions above the second fixed contacts respectively; a dome-shaped spring member made of resilient insulating material and having a top portion, a conical portion, and a lower end, the top portion and the lower end being connected by the conical portion, the lower end being placed on the base portions of the movable contacts, the top portion having a lower surface located above free ends of the resilient contact arms of the movable contacts; a push button made of rigid material and placed on the top portion of the dome-shaped spring member; and a lid member fixed to the casing and having a hole through which the push button extends, the lid member pressing the lower end of the dome-shaped spring member against the base portions of the movable contacts, the lid member supporting the push button; wherein as the push button is depressed, the dome-shaped spring member is moved by the push button and brings the resilient contact arms into contact with the second fixed contacts respectively.

A fifth aspect of this invention is based on the fourth aspect thereof, and provides a push-on switch wherein the push button has a recess, and the top portion of the dome-shaped spring member has a projection fitting into the recess of the push button to provide an engagement between the push button and the top portion of the dome-shaped spring member.

A sixth aspect of this invention is based on the fourth aspect thereof, and provides a push-on switch further comprising a key coupling provided between the push button and the lid member for allowing depression of the push button relative to the lid member while inhibiting the push button from circumferentially rotating relative to the lid member.

A seventh aspect of this invention is based on the fifth aspect thereof, and provides a push-on switch further comprising a key coupling provided between the push button and the lid member for allowing depression of the push button relative to the lid member while inhibiting the push button from circumferentially rotating relative to the lid member.

An eighth aspect of this invention is based on the fourth aspect thereof, and provides a push-on switch wherein the casing has a stem extending upward from the inner bottom surface thereof, and the top portion of the dome-shaped spring member has a hole through which the stem extends, and the push button has a recess into which the stem extends.

A ninth aspect of this invention is based on the fourth aspect thereof, and provides a push-on switch wherein the base portions of the movable contacts are connected by insulating members while lower surfaces of the base portions of the movable contacts are uncovered from the insulating members.

A tenth aspect of this invention is based on the fourth aspect thereof, and provides a push-on switch wherein the casing has a projection at the inner bottom surface thereof, the projection extending along a circle, the base portions of the movable contacts being located between the projection and an outer side wall of the casing, the projection having grooves through which the resilient contact arms of the movable contacts extend, the lower end of the dome-shaped spring member being located between the projection and the outer side wall of the casing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of a prior-art push-on switch.

FIG. **2** is an exploded perspective view of the prior-art push-on switch in FIG. **1**.

FIG. **3** is a sectional view of a 2-circuit push-on switch according to a first embodiment of this invention.

FIG. **4** is an exploded perspective view of the 2-circuit push-on switch in FIG. **3**.

FIG. **5** is a top view of a casing and related parts in the 2-circuit push-on switch in FIG. **3**.

FIG. **6** is a sectional view of a portion of an electronic apparatus including the 2-circuit push-on switch in FIG. **3**.

FIG. **7** is a sectional view of a 2-circuit push-on switch according to a second embodiment of this invention.

FIG. **8** is an exploded perspective view of the 2-circuit push-on switch in FIG. **7**.

FIG. **9** is a sectional view of a portion of an electronic apparatus including the 2-circuit push-on switch in FIG. **7**.

FIG. **10** is a sectional view of a 2-circuit push-on switch according to a third embodiment of this invention.

FIG. **11** is a sectional view of a 2-circuit push-on switch according to a fourth embodiment of this invention.

FIG. **12** is an exploded perspective view of the 2-circuit push-on switch in FIG. **11**.

FIG. **13** is a top view of the 2-circuit push-on switch in FIG. **11**.

FIG. **14** is a sectional view of a 2-circuit push-on switch according to a fifth embodiment of this invention.

FIG. **15** is a perspective view of a movable contact hoop used during the manufacture of a 2-circuit push-on switch according to a sixth embodiment of this invention.

FIG. **16** is a perspective view of a movable contact member and a casing in first conditions during the manufacture of the 2-circuit push-on switch according to the sixth embodiment of this invention.

FIG. **17** is a perspective view of the movable contact member and the casing in second conditions during the manufacture of the 2-circuit push-on switch according to the sixth embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A prior-art push-on switch will be explained below for a better understanding of this invention.

FIGS. **1** and **2** shows a prior-art push-on switch having two independent circuit switching portions. As shown in FIGS. **1** and **2**, the prior-art push-on switch includes a casing **1** having an upwardly-facing recess forming an interior thereof. The casing **1** is made of insulating resin. A lid plate **2** is fixed to an upper end of the casing **1**. A button **3** is movably supported on an upper portion of the casing **1** by the lid plate **2**. The button **3** has a body extending through a central opening in the lid plate **2**. The button **3** has a flange which can engage the lower surfaces of the lid plate **2**.

In the prior-art push-on switch of FIGS. **1** and **2**, first and second fixed contacts **4**A and **4**B are provided on the bottom surfaces **1**A of the recess in the casing **1**. The casing **1** accommodates a dome-shaped leaf spring **5** and a flexible insulating plate **6**. The leaf spring **5** extends below and contacts with the button **3**. The insulating plate **6** extends between the leaf spring **5** and the bottom surfaces **1**A of the recess in the casing **1**. First and second movable contacts **7**A and **7**B are bonded to the lower surfaces of the insulating plate **6**. The first and second movable contacts **7**A and **7**B are opposed to the first and second fixed contacts **4**A and **4**B, respectively. The leaf spring **5** has first and second downward projections **5**A and **5**B located directly above portions of the insulating plate **6** to which the first and second movable contacts **7**A and **7**B are bonded, respectively.

The prior-art push-on switch of FIGS. **1** and **2** can be changed between a normal position and an active position. The normal position corresponds to an OFF position while the active position corresponds to an ON position.

When the prior-art push-on switch is in its normal position (its OFF position), the leaf spring **5** presses the button **3** upward against the lid plate **2**. Accordingly, in this case, the button **3** is in its uppermost position. When the prior-art push-on switch is in its normal position (its OFF position), the first and second downward projections **5**A and **5**B on the leaf spring **5** are separate from the insulating plate **6**. In addition, the first and second movable contacts **7**A and **7**B on the insulating plate **6** are separate from the first and second fixed contacts **4**A and **4**B.

As the button **3** is depressed from its uppermost position to move the prior-art push-on switch out of its OFF position, the button **3** presses and deforms the leaf spring **5** toward the bottom surfaces **1**A of the recess in the casing **1**. Therefore, the first and second downward projections **5**A and **5**B on the leaf spring **5** move toward the insulating plate **6**. Then, the first and second downward projections **5**A and **5**B meet the insulating plate **6**, and then deform the insulating plate **6** toward the bottom surfaces **1**A of the recess in the casing **1**. Thus, the first and second movable contacts **7**A and **7**B on the insulating plate **6** move toward the fixed contacts **4**A and **4**B, respectively. Finally, the first and second movable contacts **7**A and **7**B simultaneously meet the fixed contacts **4**A and **4**B, respectively. When the first and second movable contacts **7**A and **7**B meet the fixed contacts **4**A and **4**B, the prior-art push-on switch falls into its ON state.

In the prior-art push-on switch of FIGS. **1** and **2**, a contact portion has many parts including the first and second fixed contacts **4**A and **4**B, the first and second movable contacts **7**A and **7**B, and the insulating plate **6**. The contact portion has a complicated shape. As previously indicated, the first and second movable contacts **7**A and **7**B are bonded to the lower surfaces of the insulating plate **6**. Accordingly, a general method of manufacturing the prior-art push-on switch has many steps. Thus, the prior-art push-on switch tends to be high in cost.

First Embodiment

FIGS. **3** and **4** show a 2-circuit push-on switch according to a first embodiment of this invention. The push-on switch of FIGS. **3** and **4** includes a casing **11** having an upwardly-facing recess of a circular or cylindrical shape. The casing **11** is made of insulating resin. The casing **11** has outer side walls **11**A extending around the recess therein. The casing **11** has an upward projection **11**B extending on the bottom surfaces of the recess therein. The upward projection **11**B extends along a circle. Thus, the upward projection **11**B has an approximately annular shape. The annular projection **11**B has a relatively small width. The annular projection **11**B extends concentrically inward of the outer side walls **11**A of the casing **11**. The annular projection **11**B is spaced radially from the inner circumferential surfaces of the outer side walls **11**A by a distance which is approximately constant throughout the circle. The annular projections **11**B has first and second grooves **11**C diametrically opposed to each other. As will be explained later, the first and second grooves **11**C are used to accommodate portions of movable contacts.

A pair of an outer fixed contact **12**A and an inner fixed contact **12**B are provided on the bottom surfaces of the recess in the casing **11** by an insert molding process. Similarly, a pair of an outer fixed contact **13**A and an inner fixed contact **13**B are provided on the bottom surfaces of the recess in the casing **11** by the insert molding process. The outer fixed contacts **12**A and **13**A are located outward of the annular projection **11**B. The inner fixed contacts **12**B and **13**B are located inward of the annular projection **11**B. A connection terminal **12**C is electrically connected to the outer fixed contact **12**A. A connection terminal **12**D is electrically connected to the inner fixed contact **12**B. A connection terminal **13**C is electrically connected to the outer fixed contact **13**A. A connection terminal **13**D is electrically connected to the inner fixed contact **13**B. The connection terminals **12**C, **12**D, **13**C, and **13**D extend out of the sides of the walls of the casing **11**, and then bend and extend downward. The connection terminals **12**C, **12**D, **13**C, and **13**D form four legs extending outward from the casing **11** and having given shapes.

As shown in FIGS. **3**, **4**, and **5**, a movable contact **14** made of a thin resilient metal plate has a base portion **14**A and a resilient contact arm **14**B. The base portion **14**A has a shape corresponding to a part of a circumference. The resilient contact arm **14**B extends from the base portion **14**A along an upwardly-sloping and inward direction. The base portion **14**A is located and supported between the annular projection **11**B and the outer side walls **11**A of the casing **11**. The base portion **14**A extends on and electrically connects with the outer fixed contact **12**A. The resilient contact arm **14**B extends through the first groove **11**C in the annular projection **11**B. A free end portion of the resilient contact arm **14**B extends above the inner fixed contact **12**B. Normally, the resilient contact arm **14**B is separate from the inner fixed contact **12**B.

Similarly, a movable contact **15** made of a thin resilient metal plate has a base portion **15**A and a resilient contact arm **15**B. The base portion **15**A has a shape corresponding to a part of a circumference. The resilient contact arm **15**B extends from the base portion **15**A along an upwardly-sloping and inward direction. The base portion **15**A is located and supported between the annular projection **11**B and the outer side walls **11**A of the casing **11**. The base portion **15**A extends on and electrically connects with the outer fixed contact **13**A. The resilient contact arm **15**B extends through the second groove **11**C in the annular projection **11**B. A free end portion of the resilient contact arm **15**B extends above the inner fixed contact **13**B. Normally, the resilient contact arm **15**B is separate from the inner fixed contact **13**B.

A dome-shaped spring member **16** made of resilient insulating material has a cylindrical lower end (an annular lower end) **16**A which is located and supported between the annular projection **11**B and the outer side walls **11**A of the casing **11**. The cylindrical lower end **16**A of the dome-shaped spring member **16** extends on the base portions **14**A and **15**A of the movable contacts **14** and **15**. The dome-shaped spring member **16** has a dome portion **16**B and a central top portion (a main portion) **16**C. The dome portion **16**B connects the cylindrical lower end **16**A and the central top portion **16**C. The dome portion **16**B has thin walls. The dome portion **16**B has a shape corresponding to a part of a cone. The central top portion **16**C has a cylindrical shape. Preferably, the central top portion **16**C is solid. The central top portion **16**C is located above the resilient contact arms **14**B and **15**B of the movable contacts **14** and **15**. Normally, the lower end surface of the central top portion **16**C is spaced from the resilient contact arms **14**B and **15**B by a predetermined distance. An upper part **16**D of the central top portion **16**C forms an operating projection to be depressed.

A lid member **17** is fixed to and located above the casing **11**. The lid member **17** and the casing **11** define a switch interior space, a part of which is formed by the recess in the casing **11**. Thus, the lid member **17** closes an upper end of the recess in the casing **11**. The casing **11** has four corners formed with upwardly-projecting dowels **11**D respectively. The lid member **17** has four corners formed with apertures through which the dowels **11**D of the casing **11** extend respectively. During assembly of the 2-circuit push-on switch, the dowels **11** of the casing **11** are deformed by a pressing process to fix the lid member **17** to the casing **11**. Edge areas of the lower surfaces **17**A of the lid member **17** abut against upper surfaces of the outer side walls **11**A of the casing **11** and also upper surfaces of the cylindrical lower end **16**A of the dome-shaped spring member **16**. Accordingly, the cylindrical lower end **16**A of the dome-shaped spring member **16** presses the base portions **14**A and **15**A of the movable contacts **14** and **15** against the outer fixed contacts **12**A and **13**A respectively. Thus, the base portions **14**A and **15**A of the movable contacts **14** and **15** are reliably in electrical connection with the outer fixed contacts **12**A and **13**A respectively.

An upper portion of the lid member **17** has a central circular hole **17**B through which the central top portion **16**C of the dome-shaped spring member **16** movably extends. Normally, the upper part **16**D of the central top portion **16**C, which forms the operating projection, extends outward of the central circular hole **17**B in the lid member **17**.

An explanation will be given of operation of the 2-circuit push-on switch of this embodiment. As shown in FIG. **6**, the 2-circuit push-on switch is mounted on, for example, a printed circuit board **18** in an electronic apparatus. With reference to FIG. **3**, when the 2-circuit push-on switch is in a normal state (an OFF state), the central top portion **16**C of the dome-shaped spring member **16** is in its uppermost position. In this case, the lower end surface of the central top portion **16**C is separate from the resilient contact arms **14**B and **15**B, and also the resilient contact arms **14**B and **15**B are separate from the inner fixed contacts **12**B and **13**B respectively.

As the central top portion **16**C of the dome-shaped spring member **16** is depressed, the 2-circuit push-on switch changes from its normal state (its OFF state) to its ON state. Specifically, with reference to FIG. **6**, as the central top portion **16**C of the dome-shaped spring member **16** is depressed via an operation button **19** in the electronic apparatus, the dome portion **16**B of the dome-shaped spring member **16** is resiliently deformed. The deformation of the dome portion **16**B generates a reactional force which gives a suitable operation feeling to the user. During the depression of the central top portion **16**C of the dome-shaped spring member **16**, the lower end surface of the central top portion **16**C meets the resilient contact arms **14**B and **15**B. Then, the central top portion **16**C of the dome-shaped spring member **16** forces the resilient contact arms **14**B and **15**B downward, and brings them into contact with the inner fixed contacts **12**B and **13**B respectively. In this way, the 2-circuit push-on switch changes to its ON state where the resilient contact arms **14**B and **15**B are in electrical connection with the inner fixed contacts **12**B and **13**B respectively. In this case, the connection terminals **12**C and **13**C are in electrical connection with the connection terminals **12**D and **13**D respectively. When the 2-circuit push-on switch assumes its ON state, the connection terminals **12**C and **13**C are elec-

trically connected to the connection terminals **12**D and **13**D respectively at substantially the same time.

When the application of the depressing force to the central top portion **16**C of the dome-shaped spring member **16** is removed, the dome portion **16**B of the dome-shaped spring member **16** returns to its original shape. As the dome portion **16**B of the dome-shaped spring member **16** returns to its original shape, the central top portion **16**C of the dome-shaped spring member **16** is moved upward. During the upward movement of the central top portion **16**C of the dome-shaped spring member **16**, the resilient contact arms **14**B and **15**B separate from the inner fixed contacts **12**B and **13**B respectively. Thus, the resilient contact arms **14**B and **15**B move out of electrical connection with the inner fixed contacts **12**B and **13**B respectively, and the connection terminals **12**C and **13**C are electrically disconnected from the connection terminals **12**D and **13**D respectively. Subsequently, the central top portion **16**C of the dome-shaped spring member **16** separates from the resilient contact arms **14**B and **15**B, and then returns to its uppermost position. When the central top portion **16**C of the dome-shaped spring member **16** reaches its uppermost position, the 2-circuit push-on switch returns to its normal state (its OFF state).

The 2-circuit push-on switch of this embodiment has a relatively simple structure. The 2-circuit push-on switch has a relatively small number of parts. Accordingly, the 2-circuit push-on switch is low in cost. In addition, the 2-circuit push-on switch can be stably operated.

It should be noted that the 2-circuit push-on switch of this embodiment may be modified into a 3-circuit or more-circuit push-on switch.

Second Embodiment

FIGS. **7** and **8** show a 2-circuit push-on switch according to a second embodiment of this invention. The 2-circuit push-on switch of FIGS. **7** and **8** is similar to the 2-circuit push-on switch of FIGS. **3**–**6** except for design changes indicated later. The 2-circuit push-on switch of FIGS. **7** and **8** includes a dome-shaped spring member **20** and a push button **21** instead of the dome-shaped spring member **16** (see FIGS. **3**, **4**, and **6**).

As shown in FIG. **7**, the whole of the dome-shaped spring member **20** is disposed in a switch interior space defined by a casing **11** and a lid member **17**. The dome-shaped spring member is made of resilient insulating material. As shown in FIGS. **7** and **8**, the dome-shaped spring member **20** has a central top portion **20**A, and a dome portion **20**C extending from the central top portion **20**A. The central top portion **20**A of the dome-shaped spring member **20** has an upper end surface **20**B which is flat. The push button **21** is made of rigid material. The push button **21** is placed on the upper end surface **20**B of the central top portion **20**A of the dome-shaped spring member **20**. The push button **21** has a cylindrical body **21**B. The push button **21** has an annular flange **21**A located at a lower end of the cylindrical body **21**B. The annular flange **21**A of the push button **21** is located in the switch interior space defined by the casing **11** and the lid member **17**. The push button **21** has a lower end surface **21**C which is flat. The lower end surface **21**C of the push button **21** contacts with the upper end surface **20**B of the central top portion **20**A of the dome-shaped spring member **20**. An upper part **21**D of the cylindrical body **21**B of the push button **21** forms an operating projection to be depressed.

The cylindrical body **21**B of the push button **21** movably extends through a central circular opening **17**B in an upper portion of the lid member **17**. In the central circular opening **17**B, there is a given small gap (a given clearance) between the lid member **17** and the cylindrical body **21**B of the push button **21**. Normally, the upper part **21**D of the cylindrical body **21**B of the push button **21**, which forms the operating projection, extends outward of the central circular hole **17**B in the lid member **17**. Normally, the flange **21**A of the push button **21** abuts against upper walls of the lid member **17**. The flange **21**A prevents the push button **21** from moving out of the lid member **17**. The flange **21**A is radially separate from inner circumferential surfaces of side walls of the lid member **17** by a given small gap (a given clearance).

An explanation will be given of operation of the 2-circuit push-on switch of this embodiment. As shown in FIG. **9**, the 2-circuit push-on switch is mounted on, for example, a printed circuit board **18** in an electronic apparatus. With reference to FIG. **7**, when the 2-circuit push-on switch is in a normal state (an OFF state), the push button **21** and the central top portion **20**A of the dome-shaped spring member **20** are in their uppermost positions. In this case, a lower end surface of the central top portion **20**A is separate from resilient contact arms **14**B and **15**B, and also the resilient contact arms **14**B and **15**B are separate from inner fixed contacts **12**B and **13**B respectively.

As the push button **21** is depressed, the 2-circuit push-on switch changes from its normal state (its OFF state) to its ON state. Specifically, with reference to FIG. **9**, as the push button **21** is depressed via an operation button **19** in the electronic apparatus, the central top portion **20**A of the dome-shaped spring member **20** is moved downward together with the push button **21** while the dome portion **20**C of the dome-shaped spring member **20** is resiliently deformed. The deformation of the dome portion **20**C generates a reactional force which gives a suitable operation feeling to the user. During the depression of the push button **21**, the lower end surface of the central top portion **20**A of the dome-shaped spring member **20** meets the resilient contact arms **14**B and **15**B. Then, the central top portion **20**A of the dome-shaped spring member **20** forces the resilient contact arms **14**B and **15**B downward, and brings them into contact with the inner fixed contacts **12**B and **13**B respectively. In this way, the 2-circuit push-on switch changes to its ON state where the resilient contact arms **14**B and **15**B are in electrical connection with the inner fixed contacts **12**B and **13**B respectively. In this case, the connection terminals **12**C and **13**C are in electrical connection with connection terminals **12**D and **13**D respectively. When the 2-circuit push-on switch assumes its ON state, the connection terminals **12**C and **13**C are electrically connected to the connection terminals **12**D and **13**D respectively at substantially the same time.

When the application of the depressing force to the push button **21** is removed, the dome portion **20**C of the dome-shaped spring member **20** returns to its original shape. As the dome portion **20**C of the dome-shaped spring member **20** returns to its original shape, the central top portion **20**A of the dome-shaped spring member **20** and the push button **21** are moved upward. During the upward movement of the central top portion **20**A of the dome-shaped spring member **20**, the resilient contact arms **14**B and **15**B separate from the inner fixed contacts **12**B and **13**B respectively. Thus, the resilient contact arms **14**B and **15**B move out of electrical connection with the inner fixed contacts **12**B and **13**B respectively, and the connection terminals **12**C and **13**C are electrically disconnected from the connection terminals **12**D and **13**D respectively. Subsequently, the central top portion **20**A of the dome-shaped spring member **20** separates from

the resilient contact arms **14**B and **15**B, and then returns to its uppermost position. As the central top portion **20**A of the dome-shaped spring member **20** returns to its uppermost position, the push button **21** also returns to its uppermost position. When the push button **21** reaches its uppermost position, the 2-circuit push-on switch returns to its normal state (its OFF state).

During the depression of the push button **21**, the cylindrical body **21**B of the push button **21** is guided along the central circular opening **17**B in the lid member **17** while the flange **21**A of the push button **21** is guided by the inner circumferential surfaces of the side walls of the lid member **17**. Accordingly, the push button **21** is moved in a substantially or exactly vertical direction without being tilted. Thus, the central top portion **20**A of the dome-shaped spring member **20** is also moved in a substantially or exactly vertical direction, enabling the resilient contact arms **14**B and **15**B to meet the inner fixed contacts **12**B and **13**B at more exactly the same time.

It should be noted that the 2-circuit push-on switch of this embodiment may be modified into a 3-circuit or more-circuit push-on switch.

Third Embodiment

FIG. **10** shows a 2-circuit push-on switch according to a third embodiment of this invention. The 2-circuit push-on switch of FIG. **10** is similar to the 2-circuit push-on switch of FIGS. **7**, **8**, and **9** except for design changes indicated later. The 2-circuit push-on switch of FIG. **10** includes a dome-shaped spring member **22** and a push button **23** instead of the dome-shaped spring member **20** and the push button **21** (see FIGS. **7**, **8**, and **9**).

As shown in FIG. **10**, the dome-shaped spring member **22** has an upwardly-extending projection **22**C of a circular cross-section. The projection **22**C extends on a central area of an upper end surface **22**B of a central top portion **22**A of the dome-shaped spring member **22**. A central area of a lower end surface **23**B of the push button **23** has a circular recess **23**C. The projection **22**C of the dome-shaped spring member **22** fits into the recess **23**C in the push button **23** so that the dome-shaped spring member **22** and the push button **23** are in engagement with each other. The push button **23** is made of rigid material.

During depression of the push button **23** to resiliently deform a dome portion **22**D of the dome-shaped spring member **22**, the engagement between the dome-shaped spring member **22** and the push button **23** via the projection **22**C prevents a radial-direction positional shift (a positional error) from occurring between the upper end surface **22**B of the dome-shaped spring member **22** and the lower end surface **23**B of the push button **23**. Thus, the central top portion **22**A of the dome-shaped spring member **22** is moved accurately along a vertical direction in accordance with vertical depression of the push button **23**, enabling resilient contact arms **14**B and **15**B to reliably meet inner fixed contacts **12**B and **13**B at more exactly the same time.

It should be noted that the 2-circuit push-on switch of this embodiment may be modified into a 3-circuit or more-circuit push-on switch.

Fourth Embodiment

FIGS. **11** and **12** show a 2-circuit push-on switch according to a fourth embodiment of this invention. The 2-circuit push-on switch of FIGS. **11** and **12** is similar to the 2-circuit push-on switch of FIGS. **7**, **8**, and **9** except for design changes indicated later. The 2-circuit push-on switch of FIGS. **11** and **12** includes a push button **24** and a lid member **25** instead of the push button **21** and the lid member **17** (see FIGS. **7**, **8**, and **9**).

As shown in FIGS. **11** and **12**, the push button **24** has an approximately cylindrical shape. Specifically, the push button **24** has a cylindrical body **24**A, and a pair of projections **24**C extending radially outward from the cylindrical body **24**A. The projections **24**C are diametrically opposed to each other. The projections **24**C also extend axially with respect to the cylindrical body **24**A. The push button **24** has an annular flange **24**B formed on a lower end of the cylindrical body **24**A. In addition, the push button **24** has a pair of projections **24**D extending radially outward from the annular flange **24**B. The projections **24**D are diametrically opposed to each other. The projections **24**D are angularly spaced from the projections **24**C by intervals of 90°. The projections **24**D also extend axially with respect to the annular flange **24**B. The push button **24** is made of rigid material.

An upper portion of the lid member **25** has a non-circular central hole **25**A. The non-circular central hole **25**A has a circular portion, and a pair of groove portions extending radially outward from the circular portion. The groove portions are diametrically opposed to each other. The groove portions also extend axially. The cylindrical body **24**A of the push button **24** movably extends through the circular portion of the non-circular central hole **25**A in the lid member **25**. The projections **24**C of the push button **24** movably fits into the groove portions of the non-circular central hole **25**A in the lid member **25**, respectively. Thus, the projections **24**C of the push button **24** engage the lid member **25**. This engagement provides a key coupling between the push button **24** and the lid member **25** which allows axial movement (vertical movement) of the push button **24** relative to the lid member **25** while inhibiting circumferential rotation of the push button **24** relative to the lid member **25**.

As shown in FIG. **13**, outer side walls **25**B of the lid member **25** have a non-circular hole or recess **25**C. The non-circular hole **25**C has a circular portion, and four groove portions extending radially outward from the circular portion. The groove portions are angularly spaced by intervals of 90°. The annular flange **24**B of the push button **24** movably fits in the circular portion of the non-circular hole **25**C in the lid member **25**. The projections **24**C and the projections **24**D of the push button **24** movably fit in the groove portions of the non-circular hole **25**C in the lid member **25**, respectively. Thus, the projections **24**C and the projections **24**D of the push button **24** engage the lid member **25**. This engagement provides a key coupling between the push button **24** and the lid member **25** which allows axial movement (vertical movement) of the push button **24** relative to the lid member **25** while inhibiting circumferential rotation of the push button **24** relative to the lid member **25**.

During depression of the push button **24**, the cylindrical body **24**A and the projections **24**C of the push button **24** are guided vertically along the non-circular central hole **25**A in the upper portion of the lid member **25** while being inhibited from circumferentially rotating. At the same time, the annular flange **24**B, the projections **24**C, and the projections **24**D of the push button **24** are guided vertically along the non-circular hole **25**C in the outer side walls **25**B of the lid member **25** while being inhibited from circumferentially rotating. Accordingly, the push button **24** is moved in a substantially or exactly vertical direction without being tilted. Thus, a central top portion **20**A of a dome-shaped spring member **20** is also moved in a substantially or exactly

vertical direction, enabling resilient contact arms **14**B and **15**B to meet inner fixed contacts **12**B and **13**B at more exactly the same time.

As shown in FIG. **11**, a lower end surface of the push button **24** has a circular recess **24**F into which the central top portion **20**A of the dome-shaped spring member **20** fits. This design enables stable vertical movement of the central top portion **20**A of the dome-shaped spring member **20** during the depression of the push button **24**.

It should be noted that the 2-circuit push-on switch of this embodiment may be modified into a 3-circuit or more-circuit push-on switch.

Fifth Embodiment

FIG. **14** shows a 2-circuit push-on switch according to a fifth embodiment of this invention. The 2-circuit push-on switch of FIG. **14** is similar to the 2-circuit push-on switch of FIGS. **7**, **8**, and **9** except for design changes indicated later. The 2-circuit push-on switch of FIG. **14** includes a casing **26**, a dome-shaped spring member **27**, and a push button **28** instead of the casing **11**, the dome-shaped spring member **20**, and the push button **21** (see FIGS. **7**, **8**, and **9**).

As shown in FIG. **14**, a stem or a shaft **26**A having a circular cross-section projects upward from a central area of bottom walls of the casing **26**. A central top portion **27**A of the dome-shaped spring member **27** has a center hole **27**B through which the stem **26**A extends. The central hole **27**B has a circular cross-section. In the center hole **27**B, there is a given small gap (a given clearance) between the stem **26**A and the central top portion **27**A of the dome-shaped spring member **27**. The push button **28** is made of rigid material. The push button **28** has an annular flange **28**A at its lower end. The push button **28** has a lower end surface formed with a central groove **28**B of a circular cross-section. The stem **26**A extends into the central groove **28**B in the push button **28**. In the central groove **28**B, there is a given small gap (a given clearance) between the stem **26**A and the push button **28**. Normally, an upper portion **28**C of the push button **28** is located outward of a central circular hole in upper walls of a lid member **17**.

The annular flange **28**A of the push button **28** slidably fits in a circular opening which is defined by outer side walls **17**C of the lid member **17**. There is a given small gap (a given clearance) between the annular flange **28**A and the outer side walls **17**C of the lid member **17**. The push button **28** is movably placed around the stem **26**A. Accordingly, the push button **28** is supported by the outer side walls **17**C of the lid member **17** and also the stem **26**A.

During depression of the push button **28**, the push button **28** is guided vertically along the outer side walls **17**C of the lid member **17** and the stem **16**A. Accordingly, the push button **28** is moved in a substantially or exactly vertical direction without being tilted. Thus, a central top portion **27**A of the dome-shaped spring member **27** is also moved in a substantially or exactly vertical direction. During the vertical movement, the central top portion **27**A of the dome-shaped member **27** is guided along the step **26**A. Therefore, the central top portion **27**A of the dome-shaped spring member **27** is prevented from shifting in a direction perpendicular to the vertical direction. Thus, the central top portion **27**A of the dome-shaped spring member **27** enables resilient contact arms **14**B and **15**B to meet inner fixed contacts **12**B and **13**B at more exactly the same time.

During assembly of the 2-circuit push-on switch of this embodiment, base portions **14**A and **15**A of movable contacts **14** and **15** are placed on outer fixed contacts **12**A and **13**A extending on upper surfaces of the bottom walls of the casing **26**. Then, the dome-shaped spring member **27** and the push button **28** are placed around the step **26**A while the step **26**A is used as a guide. Subsequently, the lid member **17** is placed so as to cover portions of the dome-shaped spring member **27** and the button **28**. Generally, the assembly of the 2-circuit push-on switch is efficient. In addition, the assembly of the 2-circuit push-on switch can be implemented on an automatic basis.

It should be noted that the 2-circuit push-on switch of this embodiment may be modified into a 3-circuit or more-circuit push-on switch.

Sixth Embodiment

A 2-circuit push-on switch of a sixth embodiment of this invention is similar to the 2-circuit push-on switch of one of the first, second, third, fourth, and fifth embodiments of this invention except for design changes indicated below.

With reference to FIG. **15**, a movable contact hoop **29** results from punching and bending a resilient metal thin plate having a belt-like shape. The punching and the bending are implemented by a pressing machine. The movable contact hoop **29** has a sequence of movable contact blocks **30** each corresponding to a pair of movable contacts **31** and **32**. Each of the movable contact blocks **30** has base portions **31**A and **32**A. The base portions **31**A and **32**A are connected to bridges **29**A by connection portions **31**C and **32**C in a manner such that two movable contacts **31** and **32** will be in a positional relation equal to a positional relation occurring in a completed 2-circuit push-on switch. Ends of the base portions **31**A and **32**A are connected by arcuate flat plates **33** of insulating resin by an outsert molding process in a manner such that lower surfaces of the base portions **31**A and **32**A remain exposed. Then, the connection portions **31**C and **32**C are removed from each movable contact block **30** by a cutting process so that the movable contact block **30** is made into a movable contact member **34** shown in FIG. **16**. The movable contact member **34** has a loop shape.

With reference to FIGS. **16** and **17**, during assembly of a 2-circuit push-on switch, the movable contact member **34** is placed on a casing **11** in such a manner as to provide the following conditions. The base portions **31**A and **32**A of the movable contacts **31** and **32** extend over outer fixed contacts **12**A and **13**A formed on upper surfaces of bottom walls of the casing **11**. Resilient contact arms **31**B and **32**B extend through grooves **11**C in an annular projection **11**B on the bottom walls of the casing **11**. Accordingly, the movable contacts **31** and **32** are placed in predetermined positions with respect to the casing **11**. Thereafter, the movable contacts **31** and **32** stably remain in the predetermined positions.

After the movable contact member **34** is placed on the casing **11**, a dome-shaped spring member **20** is placed on the movable contact member **34**. Then, a lid member **17** is placed so as to close an upper end of a recess in the casing **11**.

As understood from the above explanation, the movable contacts **31** and **32** are easily and surely located at the

predetermined positions with respect to the casing **11**. Thereafter the movable contacts **31** and **32** stably remain in the predetermined positions. Accordingly, the 2-circuit push-on switch of this embodiment is suited to automatic assembly.

It should be noted that the 2-circuit push-on switch of this embodiment may be modified into a 3-circuit or more-circuit push-on switch.

What is claimed is:

1. A push-on switch comprising:

a casing made of insulating material and having an inner bottom surface;

first fixed contacts provided on the inner bottom surface of the casing;

second fixed contacts provided on the inner bottom surface of the casing;

movable contacts having base portions and resilient contact arms, the base portions being placed on and electrically connected to the first fixed contacts respectively, the resilient contact arms extending from the base portions to regions above the second fixed contacts respectively;

a dome-shaped spring member made of resilient insulating material and having a top portion, a conical portion, and a lower end, the top portion and the lower end being connected by the conical portion, the lower end being placed on the base portions of the movable contacts, the top portion having a lower surface located above free ends of the resilient contact arms of the movable contacts; and

a lid member fixed to the casing and having a hole through which the top portion of the dome-shaped spring member extends, the lid member pressing the lower end of the dome-shaped spring member against the base portions of the movable contacts;

wherein as the top portion of the dome-shaped spring member is depressed, the dome-shaped spring member brings the resilient contact arms into contact with the second fixed contacts respectively.

2. A push-on switch as recited in claim **1**, wherein the casing has a projection at the inner bottom surface thereof, the projection extending along a circle, the base portions of the movable contacts being located between the projection and an outer side wall of the casing, the projection having grooves through which the resilient contact arms of the movable contacts extend, the lower end of the dome-shaped spring member being located between the projection and the outer side wall of the casing.

3. A push-on switch as recited in claim **1**, wherein the base portions of the movable contacts are connected by insulating members while lower surfaces of the base portions of the movable contacts are uncovered from the insulating members.

4. A push-on switch comprising:

a casing made of insulating material and having an inner bottom surface;

first fixed contacts provided on the inner bottom surface of the casing;

second fixed contacts provided on the inner bottom surface of the casing;

movable contacts having base portions and resilient contact arms, the base portions being placed on and electrically connected to the first fixed contacts respectively, the resilient contact arms extending from the base portions to regions above the second fixed contacts respectively;

a dome-shaped spring member made of resilient insulating material and having a top portion, a conical portion, and a lower end, the top portion and the lower end being connected by the conical portion, the lower end being placed on the base portions of the movable contacts, the top portion having a lower surface located above free ends of the resilient contact arms of the movable contacts;

a push button made of rigid material and placed on the top portion of the dome-shaped spring member; and

a lid member fixed to the casing and having a hole through which the push button extends, the lid member pressing the lower end of the dome-shaped spring member against the base portions of the movable contacts, the lid member supporting the push button;

wherein as the push button is depressed, the dome-shaped spring member is moved by the push button and brings the resilient contact arms into contact with the second fixed contacts respectively.

5. A push-on switch as recited in claim **4**, wherein the push button has a recess, and the top portion of the dome-shaped spring member has a projection fitting into the recess of the push button to provide an engagement between the push button and the top portion of the dome-shaped spring member.

6. A push-on switch as recited in claim **4**, further comprising a key coupling provided between the push button and the lid member for allowing depression of the push button relative to the lid member while inhibiting the push button from circumferentially rotating relative to the lid member.

7. A push-on switch as recited in claim **5**, further comprising a key coupling provided between the push button and the lid member for allowing depression of the push button relative to the lid member while inhibiting the push button from circumferentially rotating relative to the lid member.

8. A push-on switch as recited in claim **4**, wherein the casing has a stem extending upward from the inner bottom surface thereof, and the top portion of the dome-shaped spring member has a hole through which the stem extends, and the push button has a recess into which the stem extends.

9. A push-on switch as recited in claim **4**, wherein the base portions of the movable contacts are connected by insulating members while lower surfaces of the base portions of the movable contacts are uncovered from the insulating members.

10. A push-on switch as recited in claim **4**, wherein the casing has a projection at the inner bottom surface thereof, the projection extending along a circle, the base portions of the movable contacts being located between the projection and an outer side wall of the casing, the projection having grooves through which the resilient contact arms of the movable contacts extend, the lower end of the dome-shaped spring member being located between the projection and the outer side wall of the casing.

* * * * *